Special Feature ■

Presentation of the Morris F. Collen Award to Clement J. McDonald, MD

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Introduction

The American College of Medical Informatics (ACMI) is an honorary society established to recognize those who have made sustained contributions to the field. Its highest award, for lifetime achievement and significant contributions to the discipline of medical informatics, is the Morris F. Collen Award. Dr. Collen's own efforts as a pioneer in the field stand out as the embodiment of creativity, intellectual rigor, perseverance, and personal integrity. Once a year, when appropriate, the College gives its highest recognition to those whose attainments have, throughout their careers, substantially advanced the science and art of medical informatics.

In 2004, the College was proud to present the Collen Award to Dr. Clement J. McDonald (Fig. 1). Dr. McDonald has been an innovative, hands-on, and operationally oriented contributor to the field of informatics. In addition, he has proved himself the traditional academic triple threat of educator, clinical care provider, and researcher.

Life

Early Days

Clem McDonald grew up on Chicago's West Side. His father was an engineer and his mother was a schoolteacher. Of the five McDonald children, all three boys grew up to become physicians.

As a five year old, Clem first displayed the ingenuity that would become a hallmark of his life and career. He and a couple of buddies took the "El" or elevated train downtown but lacked sufficient funds to return home; young Clem panhandled for change to pay the return fare for himself and his kindergarten comrades. It was in the fifth grade that Clem read the entire World Book Encyclopedia after he contracted polio requiring a long recuperation at home.

Clem enrolled at Notre Dame where he graduated in three years with majors in chemistry, physics, and biology before attending the University of Illinois School of Medicine. During his senior year, he worked on computer diagnosis. This work was stimulated by Homer Warner's work on Bayes theorem as applied to automated diagnoses.[1]

It was during his internship at Boston City Hospital that Clem recognized the importance of tools to find and organize clinical information. He approached Octo Barnett at the Laboratory for Computer Science, hoping to pursue a fellowship in informatics while he was an intern. The time constraints of Clem's internship posed a problem.

> His fellowship consisted entirely of that one-hour conversation. I did not see him again for the remainder of his residency. Thus, he holds the distinction of having the shortest length of time of any fellowship of any of the individuals who have been at this laboratory. I will say, for a one-hour fellowship, he has really done quite well.
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> —*Octo Barnett, MD*

Early Pioneer

After finishing his internship and taking some time off to work on a novel, Dr. McDonald advanced his study of informatics at Northwestern University. There he earned a master's degree in biomedical engineering.

From Northwestern, he went to the National Institutes of Health, in Bethesda, MD. As a pathology fellow there, he managed the development of the first clinical laboratory system at the Clinical Center, writing it in assembly language on the mainframe computer. After completing his fellowship, Dr. McDonald moved back to Illinois.

Dr. McDonald devoted several more months to what he hoped would be the great American novel. When he did not find the success that he had hoped for, Dr. McDonald finished his residency in internal medicine at Cook County Hospital and the University of Wisconsin.

Regenstrief Institute

With residency behind him, Clem had an offer to stay at Wisconsin; instead, he chose the Regenstrief Institute at the Indiana University School of Medicine in Indianapolis, IN. Eugene Stead was Director of the Regenstrief Foundation at the time, but Joe Mamlin was the real attraction.

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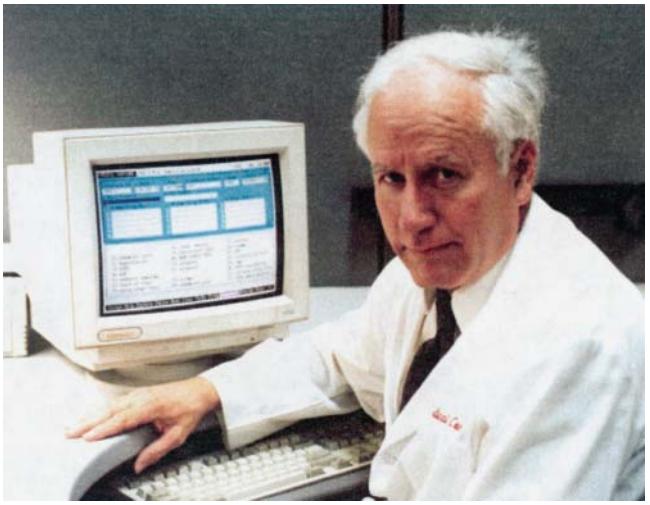

Figure 1. Clement J. McDonald, MD.

> My first decade with Clem was very interesting. I found Clem really needed two things. First of all, he needed all the goodies he could find to have all the computer resources to realize his dream. That was the easy part. Then I realized Clem needed to get into the heart of the entire hospital system. If you are going to put together a computer program, you need to get into everyone's business so he needed access to registration, the pharmacy, the lab, the pathology, the x-ray and on and on. It was clear if we were to meet our responsibility to Clem in my new role as Chief of Medicine at the hospital and his division chief I had to deliver. So, I made the decision for everything Clem needed I would go to the mat for him. I spent a full 10 years on the mat.
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> —*Joe Mamlin, MD*

Clem McDonald had found a home. He set about building his career, rising through the academic ranks at the IU School of Medicine to become a Distinguished Professor of Medicine, Regenstrief Professor, and Director of the Regenstrief Institute.

When Clem came to Indiana University in 1972, he brought with him the *idea* that electronic medical records (EMRs) could eliminate the horrible logistic problems of the paper medical record. Instead of being poorly organized, lost, and/or out of reach, electronic data would always be available, organized, and legible. EMRs could also improve the physician's *decision-making process* by automatically checking the computer-stored records for clinical events that needed attention. These capabilities were hardly imagined and nowhere operational at the time.

Dr. McDonald began his quest in a poor inner-city hospital with no federal grants, no support or encouragement from the hospital administration, and two time-share terminals linked by long-distance telephone to a five-terminal computer located 70 miles away at Purdue University. Yet, within four years, Clem had developed a working EMR in the General Medicine Clinic of Wishard Hospital, implemented a set of preventive care *reminder rules*, and published the first randomized trials of computerized decision support. That study appeared in the *New England Journal of Medicine* in 1976 and proved that computer-stored medical records could improve the process of clinical care.

Innovations

Dr. McDonald's concept of clinical reminders is among his most widely recognized innovations. To this day, he continues to evolve the concept of reminders by exploring different methods of delivery and nuances of content and timing.

Clinical standards is another area where Clem McDonald has contributed greatly. He identified the need for standards early on and has tirelessly advanced their use, form, and scope.

Dr. McDonald introduced several other innovations to the field including order entry and turnaround documents, computer-generated reports that can capture clinical data that is fed back into the repository. This concept continues to evolve today.

Always Hands-On

Dr. McDonald has always been very hands-on. A prime example is his time spent learning and using mainframe assembly language while at the NIH. Later, he wrote much of the code for the Gopher order entry system at night and on weekends.

He is also well known for his insightful comments in the code, such as ''This shouldn't work but does.''

Part of his success comes from an unflagging attention to work flow and process. Implementing new technology has never been a goal in itself, but a serendipitous by-product; Clem is always trying to address a clinical need.

At some point in nearly every project, he becomes involved in changing clinical work flow, reassigning responsibilities, or rationalizing processes. He is as diligent about data as he is about process. Whether it is part of creating an interface, designing a display, or evaluating a study, he tirelessly reviews the data. Clem is not satisfied with summary statistics; he wants to see the raw data. Similarly, while well versed in arcane statistical tests and methods, Clem always insists on being able to *see the differences* without relying on the test. He examines the test to verify that he has not been fooled by the data.

Operational Systems

Dr. McDonald has never created a system that he did not intend to be used. Physicians used the first EMR system that he created at Wishard to take care of patients in a diabetes clinic.

From that humble beginning, he created systems for registration, appointment, laboratory, pharmacy, and many others, including EMRs. All were engineered to support clinical care. At one point, Dr. McDonald had developed essentially every clinical system in use at Wishard Hospital, a large county hospital in Indianapolis.

> Clem's approach first is making sure that he and the rest of the informaticians stayed involved in the clinic milieu themselves and also keeping the real docs who practiced medicine day in and day out involved every step of the way. This was accomplished through weekly Wednesday afternoon pizza lunches, so I'm sure we have kept the local chain in business. I also know that no one but Clem with all of his energy could have consumed that much pizza over the years and maintained his youthful figure.
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> —*Lisa Harris, MD*

While some commercially available departmental systems have replaced those originals, key components, including

the longitudinal clinical data repository, order entry, and EMR systems, are still Dr. McDonald's design and creation. Key systems are used at other hospitals and by physicians' groups outside of Wishard as well. A commercial firm has sold some of the software commercially throughout the world.

Computerized Order Entry

Dr. McDonald began to develop a PC-based computer order entry (CPOE) system in 1984 when computer prices were high, their capabilities were low, video screens were low-resolution monochrome, and physicians had no vision of what computers could do. Indeed, PCs of that age had nearly three orders of magnitude *less* memory and were two orders of magnitude *slower* than today's PCs. Clem wrote much of the software himself and produced the first OE system with intelligent reminder support. The installation required rapid redesign in response to physician complaints, daily ward rounds, and communication with the users. Physicians did accept and eventually embrace this CPOE system. Formal studies proved that the system had many advantages over manual systems, including cost savings and care improvement. He published his work on this study in the *Journal of the American Medical Association* in 1993. One example of Dr. McDonald's creative approach to achieving user acceptance was to include a cartoon "task" in the Gopher system that allowed the user to see animated cartoons that changed frequently. The most popular and famous of these cartoons showed Indiana University defeating Duke University for the NCAA basketball championship.

Standards

As early as his fellowship at the NIH, Clem recognized the need to use generic methods to represent data. He developed the first widely used clinical message standard (ASTM 1238) and fostered the development and adoption of many kinds of medical informatics standards including Health Level 7 (HL7). Most recently, he developed and promoted the use of standard codes (LOINC) for identifying laboratory tests and measurements that all the largest commercial clinical laboratories have adopted.

Clinical Decision Support

Dr. McDonald often jokes that he thought he would spend only a year developing the electronic record system and then he would move on to the really fancy artificial intelligence things like automated diagnoses. The medical record system development continues even today.

In 1973, he created a decision support system that was the basis of a 1976 *New England Journal of Medicine* article. In 1979, he began to develop the CARE language that expressed decision rules more generally. This language was one of the bases for the Arden Syntax. He has embedded clinical decision support in many of the systems that he developed, including the INQuiry results retrieval application and the Gopher order entry system. Although these systems do not use artificial intelligence or Bayesian models, they are very effective tools for providing clinical decision support.

The Regenstrief research-oriented medical record system now holds more than 480 million distinct laboratory and clinical measurements, 40 million radiology images, and a variety of other kinds of data ranging from free text reports to physiologic tracings. This project required the integration of clinical, human factors, and computer science expertise. The Regenstrief Medical Record System has been connecting the central Indiana community for more than 20 years. The Indianapolis Network for Patient Care is a prime example of Clem's dedication to tackling problems that many thought were insolvable.

In 1994, he began to organize a community-wide, population-based medical record system in Indianapolis. Currently, all five major hospital systems in Indianapolis are participating in this effort along with public health departments, physician offices, laboratories, and other care providers that serve clinical care and public health and research purposes.

Always Cutting Edge but Practical

Clem was always adept at pushing the envelope in terms of technology, while managing to avoid the bleeding edge. In the early 1970s, he collaborated with computer scientists from Purdue University to write a hierarchical database manager running on top of Digital Equipment's file management services to support the development of clinical systems.

A decade later, he leapt head first into the use of microcomputers for clinical applications by creating serial communication-based interfaces between the PCs and the minicomputers that hosted the medical record system. PCs did not support networking at the time.

Training

Clem is always ready to share the insights and knowledge that he gained through these experiences. People listen to his presentations attentively for these nuggets of knowledge that he dispenses with such wit and modesty. Although he did not lead a formal fellowship program until fairly recently, he was always training a new generation. Many, like Bill Tierney and I, have benefited from his tutelage.

> Clem goes from here to out there in one step and doesn't bother with all of the steps in between. This is in his thought processes and his day to day activities, etc.—he's jumping all over the place. I got pretty good at following him. It got to the point when I was a fellow with him we would talk so quickly and make these leaps and people would see the conversation going on and nobody would have the faintest idea what we were talking about. It was fascinating to watch. It was a nonlogical sequencing way of thinking of the world and I think that is genius. One way of genius is that people would think out of the box. Clem has never seen a box, he wouldn't know what the inside of a box looked like. His thinking is intuitive and leaping from point to point.
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> —*William Tierney, MD*

His efforts were not limited to individuals at Regenstrief or Indiana University. In fact, he shared his vision with people throughout the world by spending time mentoring, editing, and advising.

Developing the Field

At the very first AMIA fall symposium that I attended, I remember the crowd of people tagging along behind Clem, trying to get his attention. It was only then that I started to understand the magnitude of his contributions to the field: from participation in the early SCAMC meetings to the founding of AMIA through memorable moments such as his impersonation of Al Gore at an AMIA meeting when

Figure 2. Clem and his colleagues singing "Oh Danny Boy."

the then Vice President failed to show and to a long-time editor of *MD Computing*.

> When you visit the city and you visit the hospitals who are participants in this network it's very clear the real secret is they trust Clem McDonald. That's why the records are there. That's why they stay there and that's why it's a good system.
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> —*Don Lindberg, MD*

Today and Tomorrow

Dr. McDonald is a constant presence. His days and often nights are spent advising policy makers, consulting with colleagues, working with fellows, seeing patients, and developing the next new idea in medical informatics. Not bad for a man who lunches daily on six Oreos and a glass of chocolate milk , who has taken up long-distance biking, and who makes singing "Danny Boy" with his colleagues an annual ritual (Fig. 2).

> I think it is also important to recognize he has a genetic mutation—most of us would eat a couple of Oreos and drink a can of Coke and get a little bit of a buzz that would last a half an hour. For some reason, when Clem has his normal lunch of Oreos and Coke he goes into hyperspeed for the next four hours in a way those of us with normal genetic profiles would not be able to do.
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> —*Paul Clayton, MD*

Family

Clem McDonald has contributed to society in an even broader sense—as a devoted family man. His daughter, Carolyn, is studying to be a nurse anesthetist, his son, Clem, is an otolaryngologist, and his son, Chris, is a computer developer. Clem's wife, Barbara, has been at his side every step of his career, cheering him on from accomplishment to accomplishment. She even convinced him to take ballroom dancing lessons. Being the true Renaissance man that he is, Dr. McDonald excelled even on the ballroom floor.

Conclusion

The ACMI is proud to recognize Dr. Clement J. McDonald for his long-standing contributions to the profession. He has been honored by others with the Blue Horizon Award, the Nicholas Davies Award, and membership in the Institute of Medicine, but recognition by *your peers* is the highest honor that anyone can receive. I am sure that the Morris F. Collen Award will stand apart and hold a special place in Clem McDonald's heart.

> You know he's famous for his rendition of a song we learned a long time ago at an Irish pub during a SCAMC meeting in Washington, DC. It's possible with proper encouragement we could get him to sing to us in his Irish tenor.
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> Oh Danny Boy the pipes, the pipes are calling from glen to glen and down the mountainside.
>
> Congratulations old friend on this honor—you are playing great pipes in many a glen and across many a mountainside.
>
> —*Octo Barnett, MD*

Reference ■

1. Warner HR. The role of computers in medical research. JAMA. 1966;196:944–9.